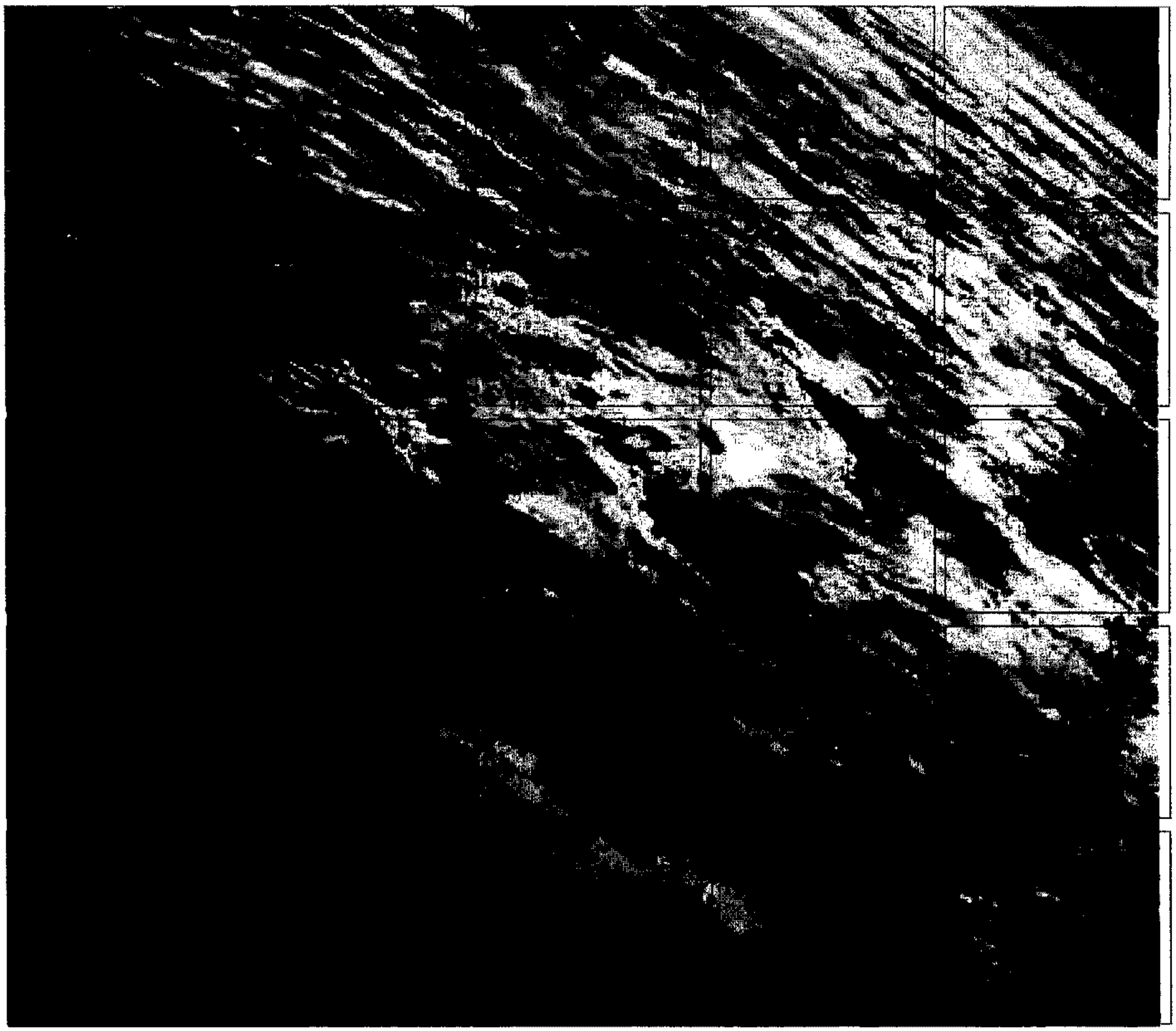

Former Seaboard Chemical/Riverdale Drive Landfill Site
Jamestown, North Carolina

Sampling and Analysis Plan

July 11, 2008

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Landfill Site

Sampling and Analysis Plan

July 11, 2008

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1.0 *INTRODUCTION*

This Sampling and Analysis Plan (SAP) defines the sampling and analytical guidelines to be utilized during implementation of the remedial action program to be conducted at the former Seaboard Chemical Corporation/City of High Point Riverdale Drive Landfill Site (the Site) in Jamestown, Guilford County, North Carolina. A site location map is presented in Figure 1 and a site map is presented in Figure 2. The sampling activities during the remedial action will consist primarily of additional ground water and surface water sampling and analyses and water level gauging. However, the SAP addresses sampling and analyses of soil and sediment as well as ground water and surface water. The overall objective of the SAP is to facilitate proper collection of data that are qualitatively and quantitatively sufficient to meet the data quality objectives for the remedial action.

This plan was prepared by ERM NC, PC on behalf of the Seaboard Group II and the City of High Point. The SAP was prepared pursuant to the pending Administrative Order on Consent ("AOC") with North Carolina Department of Environment and Natural Resources (NCDENR). The SAP is in general accordance with the current U.S. Environmental Protection Agency (EPA) Region IV Environmental Investigations Standard Operating Procedures and Quality Assurance Manual and the current NCDENR Inactive Hazardous Sites Program Guidelines for Assessment and Cleanup.

2.0 *DATA QUALITY OBJECTIVES*

The primary data quality objective (DQO) is to provide well-documented, consistent, and technically defensible data that can be used to evaluate the remediation of constituents of potential concern (COPCs) in environmental media at the Site. Application of the DQO process will facilitate the collection of appropriate data and support the implementation of the remedial action that is protective of human health, public welfare, and the environment, and that is consistent with the future land use.

Four types of data will potentially be collected during the project, each having a specific DQO.

Data	**DQO**
1. Ground Water Quality Data	Collection of sufficient data to monitor and assess the effectiveness of the remedy to ensure that there is no unacceptable migration of contaminants from the site via ground water
2. Soil (Surface and Subsurface) Quality Data	Collection of sufficient data to monitor and assess potential human health and environmental risks from historical site activities based on the future land use
3. Surface Water and Sediment Quality Data	Collection of sufficient data to monitor and assess the effectiveness of the remedy to ensure that there is no unacceptable migration of contaminants to the Randleman Reservoir /Deep River and the Southern Intermittent Stream
4. Laboratory Analytical Testing Data	Accurate analysis of media samples for use in assessment of he effectiveness of the remedy

3.0 DATA QUALITY ASSURANCE AND QUALITY CONTROL

3.1 QUALITY CONTROL (QC) ASSESSMENT PARAMETERS

Review of analytical data will be performed by ERM and qualified contract laboratories. The data will be evaluated based on the parameters of precision, accuracy, representativeness, comparability, and completeness. These parameters are discussed below, along with an example of an element of QC used to assess the parameter, if applicable.

QC Parameter	Definition
Precision	Agreement or reproducibility among individual measurements of the same parameter, usually made under the same conditions (e.g., using the same test procedure). For instance, the matrix spike duplicate (MSD) will be used to assess total analytical precision by calculating the relative percent difference (RPD) between the original matrix spike and duplicate analysis for a given constituent.
Accuracy	Degree of agreement of a measurement between the known value and the measured value. Analytical accuracy will be measured, for example, by comparing the percent recovery (%R) of analytes spike into a laboratory control sample (LCS) to a control limit.
Representativeness	Degree to which a measurement accurately and precisely represents a characteristic of a population, parameter or variation at a sampling point, a process condition, or an environmental condition. Representativeness will be achieved through use of standard field, sampling and analytical procedures and is not measured by a specific element of QC.
Completeness	A quantitative characteristic that is defined as the fraction of valid data obtained from a measurement system (e.g., sampling and analysis) compared to that which was planned. Valid data are defined as all data that did not receive a rejected ("R") flag during the data validation.
Comparability	An expression of the confidence with which one data set can be compared to another. Comparability is a qualitative characteristic that allows for comparison of analytical results with those obtained by other laboratories. Comparability will be achieved by using standard methods for analysis, reporting data in standard units, normalizing results to standard conditions and using standard and comprehensive reporting formats.

For each analysis, the laboratory will have established, quantitative QC elements and protocols for precision, accuracy, and detection limits based on USEPA methods, laboratory method validation studies, and/or laboratory experience with similar samples.

3.2 *ELEMENTS OF QUALITY CONTROL (QC)*

3.2.1 *Laboratory Quality Control*

In order to verify that chemical analyses and laboratory QC are consistent with EPA protocols, a laboratory that follows EPA's Contract Laboratory Program (CLP) will perform the chemical analyses. Precision and accuracy will be assessed in the laboratory using, at a minimum, the following elements of QC. The execution of these elements and the frequency of use will be in general accordance with applicable USEPA SW-846 or other method requirements. The %R and RPD limits for each of these elements will be determined by the laboratory as appropriate for the USEPA SW-846 method or other method.

Laboratory Control Sample (LCS): The laboratory control sample is analyte-free water (for aqueous analyses), Ottawa sand or other solid matrix determined to be analyte-free (for soil analyses) which, at a minimum, is spiked with known quantities of the constituents of concern.

Matrix Spike/Matrix Spike Duplicate (MS/MSD): The MS and MSD are aliquots of sample medium spiked with known concentrations of constituents of concern prior to extraction/analysis of the sample. Additional sample volumes will be collected in the field in order to perform these analyses and the same will be documented on a chain-of-custody form. The frequency of collection for MS/MSD analysis is discussed in Section 3.2.2.

Surrogates: Surrogates are organic constituents that are similar to the target analytes in chemical composition and behavior in the analytical process, but are not normally found in the environmental samples. Surrogates are spiked at known concentrations into the environmental sample prior to analysis.

Internal Standards (IS): Internal Standards are measured amounts of certain constituents added after preparation or extraction of a sample in order to correct sample results affected by extraction losses, column injection losses, purging losses or viscosity effects.

Method Blank (MB): The method blank is an analyte-free matrix that is carried through the complete sample preparation and analytical procedure.

3.2.2 *Field Quality Control (QC)*

The following four elements will be utilized to assess quality control in the field. The type of sample and analysis is discussed, as well as the QC benefit provided.

Trip Blank: The trip blank will be prepared in the laboratory, transported to the Site, and handled in the same manner as other samples, except that it will remain unopened. The trip blank will be returned to the laboratory for analysis by USEPA SW-846 Method 8260B to ensure that contamination was not introduced to samples via transportation or handling procedures.

Equipment Blank: The equipment blank will be prepared in the field using deionized (DI) water (or similar). The water will be poured over/through sampling equipment that has been previously decontaminated, collected in sample bottles and analyzed for select parameters. The purpose of this blank is to ensure that equipment is being properly decontaminated and not introducing contaminants to the samples.

Field Blank: The field blank will be prepared in the field by pouring DI water (or similar) into sample containers in the same vicinity as the associated samples, and leaving the containers open to ambient conditions during the filling of sample bottles with environmental media. The field blank containers will be closed after the associated samples are collected and will be submitted to the laboratory for analysis of select parameters. The purpose of the field blank is to assess the potential introduction of contaminants from field sources (e.g., gasoline motors, wind-blown dust) during sample collection.

Field Duplicates: Field duplicate samples will be second, co-located samples collected at the same location and using the same methods as the original investigative sample. The analytical results of field duplicate samples will provide some indication of the homogeneity of the sample medium and the precision of the field sampling and laboratory analysis. Accurate field notes will be taken to ensure that each duplicate can be matched to its corresponding investigative sample.

QC samples will be named as described in Section 5.2. Field duplicates, MS/MSDs, field blanks, equipment blanks, and trip blanks will be collected at the frequency shown in the table below for each analysis of interest.

QC Sample	Frequency
Trip Blanks	1/day/cooler containing VOC samples
Equipment Blanks	1/20 samples/matrix
Field Blanks	1/20 samples/matrix
Field Duplicates	1/day/matrix or 1/20 samples/matrix (1)
MS/MSD	1/20 samples/matrix

Note:
(1) The actual frequency will be the lesser of the two shown.

3.3 *DATA VALIDATION*

The laboratory analytical data will be reviewed for accuracy and precision by the laboratory before the data are reported. Potential QC-related issues may necessitate a re-analysis of samples based on the discretion of the laboratory and the ERM Project Manager (or his or her designee) and applicable criteria from the USEPA SW-846 method. The laboratory will communicate QC problems to the ERM Project Manager (or his or her designee) as they become apparent.

Once the laboratory data are reported, the data packages will be reviewed by the ERM Project Manager (or his or her designee) to verify that samples are properly identified and inventoried, sample holding times and temperatures are not exceeded, and the appropriate documentation is being completed. The data packages will be validated when practicable by employing procedures and policies identified in the most recent edition of the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* and *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (Functional Guidelines).* Based on the Functional Guidelines, qualifier flags may be added to data that do not meet the QC criteria.

The ERM Project Manager (or his or her designee) will review the data to assess completeness and, as required, consistency with previous laboratory reports and procedures.

4.0 SAMPLING MATERIALS AND METHODS

4.1 SAMPLING STRATEGY AND RATIONALE

Environmental media that may be included in the sampling program include surface and subsurface soils, surface sediment, surface water bodies, and ground water. The locations of samples and rationale for sample locations for this project will be discussed in a project-specific work plan, as appropriate.

4.2 RECONNAISSANCE AND SURVEYING

In general, sample locations will be mapped using standard surveying methods, a global positioning system (GPS) unit or other appropriate methodology.

4.3 SAMPLING EQUIPMENT

This section will describe the overall equipment needs for sampling various environmental media at the Site during remedial action. A general equipment list is presented in Table 1.

Ground water samples will be collected from monitor wells using an appropriate peristaltic or submersible pumping system or a Teflon bailer.

Surface water sample will be collected using the sample container or, for deeper samples, a sub-surface grab sampling device (i.e. Kemmerer-style sampler).

Most soil and ground water subsurface investigation and sampling activities will be accomplished through the advancement of borings to various depths using industry standard drilling equipment (direct push or rotary drilling rigs, equipped with hollow stem augers, shelby tubes, core barrels, or similar devices). Direct push drilling technology is preferred (e.g., Geoprobe® Sampling System or Cone Penetrometer Test (CPT) devices) for the collection of soil, ground water and lithologic information. Direct push samples will be obtained using either stainless steel, split-spoon samplers, a steel macro-core sample barrel with disposal acetate sleeves, or similar technology(ies).

Borings will be completed using equipment that is appropriate for the sampling needs and the investigation depth desired. In addition to drilling technologies, a stainless steel hand auger, stainless steel hand trowels, or similar equipment, may be used when collecting surface soil samples.

Test boring and monitor well installation activities will be performed by a qualified drilling subcontractor licensed by the State of North Carolina.

Sample bottles and preservatives appropriate for the constituent to be analyzed, distilled water, coolers, and ice will also be utilized. Table 2 summarizes sample bottle type, preparation, preservation requirements, and sample hold times.

4.4 *CALIBRATION PROCEDURES AND FREQUENCY*

Calibration procedures and frequency of calibration represent accepted techniques to facilitate accurate sampling, monitoring, testing, and documentation of field work. Field instruments, such as pH, temperature, turbidity, and specific conductivity meters, will be standardized/calibrated according to manufacturers' instructions. Appropriate calibration records will be maintained in project field records.

It is also important to occasionally check each piece of equipment in general accordance with the manufacturer's instructions to confirm that it is responding to the presence of constituents in site media. These checks are critical and provide confidence to the user that the instrument is functioning properly.

A wide variety of meters and other equipment are available for field parameter measurements. Monitoring instrumentation will be operated in accordance with USEPA methods, if applicable, and the operating instructions provided by the manufacturer. Instruments that may be used for field data collection, and thus will require routine calibration in accordance with manufacturers' specifications, are as follows:

- pH, Eh, Specific Conductivity, Dissolved Oxygen, And Temperature Meters;
- Turbidity Meters; and
- Organic Vapor Analyzer, or OVA (e.g., PID or FID).

OVA monitoring equipment will typically be used throughout the workday. If relatively elevated headspace readings are measured with this equipment, it will be recalibrated using the appropriate calibration procedures.

4.5 *EQUIPMENT DECONTAMINATION*

All reusable or recyclable equipment, tools, and materials will be decontaminated before being used on-site. Sampling equipment will be obtained pre-cleaned or cleaned on-site prior to being used for collecting samples. Non-dedicated or non-disposable sampling equipment will be decontaminated following the general procedure:

- Scrub with a solution of potable water and laboratory grade, phosphate-free detergent;
- Rinse with potable water;
- Rinse with DI water;
- Rinse twice with pesticide-grade isopropanol;
- Rinse with DI water;
- Air dry; and
- Place in a clean polyethylene bag or wrap in aluminum foil when not in use and during transport, if necessary.
- For inorganic samples only: Rinse with 10% nitric acid (HNO_3) (1% for split spoons);

If metal samples are not being collected, the 10% nitric acid rinse will be omitted. If organic samples are not collected, the solvent rinse may be omitted.

Disposable equipment (e.g., gloves, tubing) will be used for some sampling activities. For these activities new equipment will be used at each sample location.

4.6 *SAMPLE COLLECTION*

This section discusses the sample collection and handling procedures applicable to various environmental media.

Samples for laboratory analysis will be collected according to the specifications of the analytical laboratory with regard to container-type, sample preservation, and sample volume (see Table 2).

Each sample will be handled wearing new, disposable latex or Nitrile® gloves. Each soil or sediment sample will be transferred from the sample preparation area, sampler, or stainless steel bowl to new, clean, laboratory-supplied containers appropriate for the anticipated analysis. Each ground water or surface water sample will be transferred from the sampler to new, clean, laboratory-supplied containers appropriate for the anticipated analysis. Each surface water sample will be collected in new, clean, unpreserved sample containers and then transferred directly into laboratory-provided containers appropriate for the anticipated analysis, with the exceptions noted previously. Once filled, all sample container lids shall be immediately closed tightly to seal the sample.

The typical sample storage requirements will be as follows:

- Samples will be stored and transported on ice in an insulated cooler nominally at 4 degrees Celsius (°C);
- Samples will be protected from freezing by storing in a temperature regulated space where necessary;
- All soil or sediment samples will be stored in air-tight jars and/or double-bagged in plastic, with as much air as practical evacuated from the bags; and
- All samples will be stored in a safe place under strict chain-of-custody procedures to preclude any loss or disturbance.

Specific sample collection and handling procedures are listed in Sections 4.8 through 4.13.

4.7 *ANALYTICAL PARAMETERS AND METHODS*

The proposed analytical parameters for media at the Site have been developed from both site historical data and analyses performed during the remedial investigation and routine monitoring. The primary compounds of potential concern at the site are listed below and include volatile and semivolatile organic compounds. A general list of compounds and associated analytical methods is provided in Table 2.

Hazardous Substances Known to be Present Former Seaboard Chemical/Riverdale Drive Landfill Site	
Soils	
Acetone	Toluene
2-Butanone	Xylene
Chlorobenzene	Bis(2-Ethylhexyl)Phthalate
1,2-Dichloroethane	Endrin Aldehyde
Ethylbenzene	Toxaphene
Tetrachloroethene	
Ground Water	
1,1,1-Trichloroethane	Tetrachloroethene
1,1,2-Trichloroethane	Toluene
1,1-Dichloroethane	Trichloroethene
1,1-Dichloroethene	Vinyl Chloride
1,2-Dichloroethane	Xylene
trans-1,2-Dichloroethene	2,4,6-Trichlorophenol
cis-1,2-Dichloroethene	2-Methylnaphthalene
1,4-Dioxane	1,2-Dichlorobenzene
2-Butanone	Acetophenone
Acetone	Benzoic Acid
Benzene	Dimethylphthalate
Chlorobenzene	Isophorone
Chloroform	Naphthalene
Eyhylbenzene	Parathion
Methylene Chloride	Phenol
Surface Water	
1,1,1-Trichloroethane	1,4-Dioxane
1,1-Dichloroethane	Chlorobenzene
1,1-Dichloroethene	Chloroethane
1,2-Dichloroethane	Methylene Chloride
cis-1,2-Dichloroethene	Vinyl Chloride

4.8 *SURFACE AND SUBSURFACE SOIL SAMPLING*

Surface and subsurface soil sampling activities have been completed at the site as part of the RI/FS phase of work. Soil sampling is not planned during the remedial action but, if necessary, the methods described in this section will be employed.

4.8.1 *Soil Sampling Locations*

Locations and depths of soil samples will be selected to satisfy the objectives of the investigation and will be discussed in a project-specific work plan, as appropriate.

4.8.2 *Soil Sample Collection*

Prior to soil sample collection, the ground surface will be prepared by clearing away brush, roots, grass, leaves, and other debris from the sample location. Soil classification and lithologic descriptions will be recorded as per Section 4.8.4.

The procedure for collecting investigative soil samples is as follows:

- The soil borings will be advanced through unconsolidated material via direct push drilling technology, in general.
- Soil samples will be collected continuously from the surface to the total depth of each boring with individual samples for analysis being collected generally in 1-ft. increments at the intervals specified in the work plan.
- Immediately following the collection of each sample, the sample will be extruded and visually inspected. The outer 1/8- to 1/4-inch of the sample will be removed as well as any obvious "collapsed" material at the end of the sampling device. A portion of the sample will be immediately placed into a 4-ounce glass jar appropriate for VOC analyses, if necessary, and a portion from each sample interval will be retained for field screening as described in Section 4.8.3. A description of the physical characteristics of the sample will also be noted in the field records. For composite samples where VOC analysis will be necessary, the grab sample with the highest field screening measurement (in accordance with Section 4.8.3) will be used for VOC analysis and will represent the composite sample.
- The remaining soil recovered in the sampler will be placed into a clean bowl and mixed thoroughly (homogenized) in a decontaminated stainless steel bowl prior to filling the sample containers. Sample preservation techniques for these parameters are discussed in Section 5.1.

- Each sample will be labeled and stored in an insulated cooler to a nominal temperature of 4°C.
- At those locations where duplicate samples or split samples are required, an additional boring may be installed immediately adjacent to the original boring in order to have sufficient soil volume for the required analyses.
- Upon completion of each boring, the borehole will be abandoned in accordance with Section 4.8.5.

For surficial soil sampling, stainless steel hand trowels or augers may be used to collect the samples. If direct push drilling technology, other than a CPT rig, is used for surface and/or subsurface sampling, it will be equipped with a 2-inch outside diameter, steel, macro-core sample barrel with disposal acetate sleeves, or similar equipment, for sampling.

Soil samples will be analyzed as per Section 4.7 (Analytical Parameters and Methods).

4.8.3 Headspace Screening

Each sample for VOC analysis will be placed in a sealed container (e.g., one-gallon sealable plastic bag). Headspace will then be measured using an FID or PID within approximately 5 minutes after the samples have reached a temperature between 20°C (68°F) and 32°C (90°F). One of the readings will be obtained using an activated charcoal filter unless the unfiltered reading is at or below background. A total corrected hydrocarbon measurement will be determined by subtracting the filtered reading from the unfiltered reading.

4.8.4 Soil Classification

Soil (lithologic or environmental) samples will be inspected and logged by a qualified geologist or his or her designee. The soil description will be recorded in the field notebook and, in general, will follow the Universal Soil Classification System format

An example of a typical soil description will include: stiff, gray, stratified, SILTY CLAY, trace sand, etc. Additional descriptions such as odor, staining, oily sheen, saturation, or moisture, etc., will also be noted in the field records, when present.

4.8.5 Borehole Abandonment

Following boring advancement and sampling activities, any boreholes not completed as temporary or permanent monitor wells will be abandoned using industry standard procedures and applicable NCDENR guidelines.

4.90 *SEDIMENT SAMPLING*

Sediment sampling activities have been completed at the site as part of the RI/FS phase of work. Sediment sampling is not planned during the remedial action but, if necessary, the methods described in this section will be employed.

4.9.1 *Sediment Sampling Locations*

Locations and depths of sediment samples will be selected to satisfy the objectives of the investigation and will be discussed in a project-specific work plan, as appropriate. In general, sediment samples will be collected from on-site and off-site areas where surface water and/or storm water is conveyed (e.g., streams, drainage ditches or low-lying areas of the Site). In general, samples will be collected from the centerline of a ditch or midpoint of a low-lying area.

4.9.2 *Sediment Sample Collection*

Sediment sampling equipment and methods will be followed as outlined in Section 11 of USEPA Region IV Environmental Investigation Standard Operating Procedures and Quality Assurance Manual (EISOPQAM). Sediment samples will be collected from the bottom surface of the water body (whether water is present or not) to approximately six inches below the bottom surface. Deeper sediment samples may be collected pending the results of the initial sampling activities. If the surface water flow and depth are shallow and the sampling area is easily accessible, a trowel or hand scoop may be used to collect the material. However, if the water above the sediment is deeper than approximately six inches, a sediment coring device will be used to reduce the potential for washing the sediment when it is retrieved. A decontaminated stainless steel trowel or spoon will be utilized to transfer the sediment from the sampling device directly into a sample container. If necessary, excess water should be decanted from the sample. Larger pebbles, leaves and twigs should also be removed from the sample matrix prior to placing the sediment in the sample container. As appropriate and practical, excess sediment and/or water generated during these sampling activities will be spread at the sample collection point or later transferred to an appropriate container for disposal as investigation derived waste (see Section 4.14).

Sediment samples will be analyzed as per Section 4.7 (Analytical Parameters and Methods).

4.10 *SURFACE WATER SAMPLING*

Surface water samples will be collected from Randleman Lake (formerly the Deep River) and from the Southern Intermittent Stream (SIS). Historically, surface water has also been sampled from the Northern Intermittent Stream (NIS). However, as part of the remedial design, the NIS will be diverted around the perimeter of the site and the affected areas and will not be monitored.

4.10.1 *Surface Water Sample Locations*

Surface water samples will be collected from the locations specified in the *Remedial Monitoring and Effectiveness Evaluation Plan* or other project-specific work plan. If other surface water monitoring is necessary, locations will be selected to satisfy the objectives of the investigation.

4.10.2 *Surface Water Sample Collection*

Grab samples of surface water will be manually collected from mid-depth, if possible, using a discrete interval sampling device (e.g., a "bomb" sampler). Field parameters will be measured before samples are collected by collecting a grab sample of surface water using a new, clean, unpreserved sample jar to measure the pH, Eh, temperature, dissolved oxygen, turbidity and specific conductance. Field parameters will be noted in the field records.

4.11 *MONITOR WELL INSTALLATION*

Monitor well installation activities have been completed at the site as part of the RI/FS phase of work. Monitor well installation is not planned during the remedial action but, if necessary, the methods described in this section will be employed.

4.11.1 *Monitor Well Locations*

Monitor wells locations will be specified in the project-specific work plan. If monitor wells are necessary, locations and depths will be selected to satisfy the objectives of the investigation.

4.11.2 *Monitor Well Installation Procedures*

Ground water monitor wells will be installed by a qualified water well driller, experienced in environmental investigations and licensed by the State of North Carolina. Well construction will be conducted in accordance with applicable NCDENR well construction standards. All (temporary and permanent) monitor wells will be installed immediately after the boreholes are completed. Specifically, temporary and permanent monitor well installation will be completed using the procedures outlined in the following subsections.

4.11.2.1 *Temporary Well Installation & Ground Water Grab Sample Procedures*

In general, temporary ground water monitor wells will be constructed using a 1- or 2-inch diameter, flush-threaded Schedule 40 polyvinyl chloride (PVC) casing and a 10-foot or 15-foot section of 0.010-inch slotted Schedule 40 PVC screen. No glue joints will be used. The screen will be set at a depth that intercepts the water table and accounts for historical water table fluctuations and the water table at the time of installation. Screen length and depth for each well will be subject to modifications in the field as directed by the field geologist or his/her designee and will be dependent upon encountering suitable water-bearing zones.

An appropriately-sized filter pack will be used to fill the annular space between the borehole and the well and will keep fine-grained materials from clogging the well screen. This filter pack will be tremied from the bottom of the borehole to a depth approximately two feet above the screened interval.

Alternatively, discrete ground water grab samples will be obtained from each of the soil boring locations by a Geoprobe™ Screen Point 15 Ground Water Sampler or similar device. The device can be advanced to the selected depth in saturated, unconsolidated materials, and opened at the desired depth to collect a representative and uncompromised grab sample from the desired interval.

4.11.2.2 *Installation of Permanent Monitor Wells*

In general, permanent ground water monitor wells will be constructed using a 2-inch diameter, flush-threaded Schedule 40 PVC casing and a 10-foot or 15-foot section of 0.010-inch slotted Schedule 40 PVC screen. No glue joints will be used. The screen will be set at a depth that intercepts the water table and accounts for historical water table fluctuations and the water table at the time of installation. Screen length and depth for each well will be subject to modifications in the field as directed by the field geologist or his/her designee and will be dependent upon encountering suitable water-bearing zones.

An appropriately-sized filter pack will be used to fill the annular space between the borehole and the well and will act as a filter to keep fine-grained materials from clogging the well screen. This filter pack will be tremied from the bottom of the borehole to a depth approximately two feet above the screened interval. A two to five-foot thick bentonite slurry will be pumped above the sand pack to provide a low permeability seal. The remainder of the annulus will be filled with bentonite/Portland® cement grout. A three foot by three foot concrete pad with protective casing surrounding the well casing and four, three-inch diameter guard posts will be installed around each monitor well. The protective casing around each well will be secured with a common lock.

4.11.2.3 *Alternate Well Installation Procedure*

In the event a greater potential for surface contamination exists, wells will be drilled and installed using double- or triple-casing to reduce the potential for cross-contamination of the borehole from the shallow soils during the well installation or to isolate the deeper zone within the uppermost water bearing zone. Well installation will likely involve use of the same equipment and well materials as previously described with the addition of appropriate casing installed in a telescoping fashion.

4.11.2.4 *Well Development*

Wells will be developed following their installation using a submersible pump, dedicated bailer, peristaltic pump, or a plastic surge block attached to semi-rigid tubing. If necessary, monitor wells will be developed using a combination of bailing and/or pumping to produce representative ground water from the formation. Development will be continued until representative water, free of drilling fluids, cuttings, or other materials introduced during well construction is observed. For the purposes of this investigation, representative water is obtained when pH, temperature, and specific conductance measurements stabilize to within ± 0.1 standard units, ± 0.5°C, and ± 10%, respectively, and the water is relatively clear of suspended solids (less than 20 Nephlometric Turbidity Units (NTU)).

The minimum duration of well development will vary in accordance with the method used to develop the well. For example, surging and pumping the well may provide a stable, sediment-free sample in a matter of minutes; whereas, bailing the well may require several hours of continuous effort to obtain a clear sample. In the event that field measurements do not stabilize, a minimum of ten well casing volumes will be removed, if possible. The duration of well development, the volume of water removed, and the pH, temperature, turbidity and specific conductance readings will be recorded by an ERM professional assigned to oversee these work elements.

The development and purge water will be containerized and treated on-site using the approved remediation treatment system in accordance with state and federal regulations and/or discharged to the local POTW.

4.12 *GROUND WATER ELEVATION MEASUREMENTS, SAMPLING AND AQUIFER TESTING*

4.12.1 *Monitor Well Network Locations*

Ground water samples and elevation measurements will be collected from the locations specified in the *Remedial Monitoring and Effectiveness Evaluation Plan* or other project-specific work plan. If other ground water monitoring is necessary, locations will be selected to satisfy the objectives of the investigation.

4.12.2 *Water Level Measurements*

Water level measurements will be taken prior to purging and sampling each well using a decontaminated, electronic water level indicator. The measurements will be recorded in feet with accuracy to the nearest hundredth of a foot. The following procedure will be used to measure static water levels.

- Lower a decontaminated, electronic water level indicator probe down into the well until the water level indicator responds.
- Raise and lower the probe several times to verify the water table has been detected and to refine the depth measurement.
- Read and record the water level depth and the unit of measurement.
- After measuring the depth to static water, rinse the reel and tape with deionized water as the cable is reeled back.
- The preferential sequence of measurements is to start with at least impacted wells first followed by impacted wells (if any) to reduce the potential for cross-contamination.
- The well casing volume will be calculated as follows:
  - Depth to water (feet) = h
  - Depth of well (feet) = H
  - Radius of well (inches) = r
  - Volume of water in the well casing including the screen (gallons)
  - $= \pi \times (r^2) \times (H-h) \times 7.481$
    where 7.481 is a conversion factor from cubic feet to gallons.

4.12.3 *Ground Water Sample Collection*

Ground water sampling will be conducted in general accordance with the purging and sampling procedures outlined in the EISOPQAM, specifically

Section 7, and *Low Flow (Minimal Drawdown) Groundwater Sampling Procedures (EPA/540/S-95/504)* dated December 1995. Ground water samples will be analyzed as per Section 4.7 (Analytical Parameters and Methods).

4.12.3.1 *Well Purging and Stabilization*

Field ground water parameters, measured during the well sampling activities, will include pH, specific conductance, turbidity, dissolved oxygen, Eh, and temperature. These parameters will be measured and recorded as indicators of ground water quality and for potential correlation to other data. Because pH, temperature, and specific conductance of a ground water sample can change significantly shortly following sample collection, these parameters must be measured in the field unfiltered and unpreserved in a clean glass container separate from those intended for laboratory analysis. Each instrument used to measure these parameters will be calibrated and operated in accordance with the manufacturer's instructions.

To facilitate the collection of representative ground water samples from the formation, a minimum of one well volume will be removed, and the pH, specific conductance, temperature, and turbidity of the ground water will be stabilized (see Section 4.12.2.4 for discussion of stabilization) prior to collecting samples for analysis.

4.12.3.2 *Ground Water Sample Collection*

Wells will be purged with a low-flow pump in general accordance with *Low Flow (Minimal Drawdown) Groundwater Sampling Procedures (EPA/540/S-95/504)* dated December 1995. Purging at each well location will continue until specific parameters stabilize (i.e., when three successive readings for pH, temperature, and specific conductance measurements stabilize to within ± 0.1 standard units, ± 0.5°C, and ± 10%, respectively, and the water is relatively clear of suspended solids (less than 20 Nephlometric Turbidity Units (NTU)) or until one hour has elapsed. Water quality parameters will be measured using an in-line, flow-through cell and parameter values will be recorded on a data logger or noted elsewhere on the field records. All instruments will be calibrated in accordance with the respective manufacturer's instructions prior to use. Ground water samples will be analyzed as per Section 4.7 (Analytical Parameters and Methods).

4.12.4 *Hydraulic Testing (Slug Test)*

Hydraulic testing activities have been completed at the site as part of the RI/FS phase of work. Slug testing is not planned during the remedial action but, if necessary, the methods described in this section will be employed.

Variable head permeability tests will be conducted on select permanent monitor wells to estimate the localized hydraulic conductivity and transmissivity of the water bearing zone.

Falling head slug tests will be performed by instantaneously removing a solid PVC slug of known volume from the stabilized water column in a well. Changes in water level due to the removal of the slug will be measured and recorded using an electronic data logger equipped with a pressure transducer, or a water level meter. The slug test data will be analyzed using AQTESOLV™ or similar analysis software.

4.12.5 *Natural Attenuation Evaluation*

Natural attenuation monitoring and evaluation activities will be conducted during the remedial action as part of the ground water monitoring program. Ground water samples for natural attenuation analysis will be collected from the locations specified in the *Remedial Monitoring and Effectiveness Evaluation Plan* or other project-specific work plan. The ground water sample collection procedures are described in Section 4.12.3. Natural attenuation parameters to be analyzed include the following:

- Dissolved oxygen
- Nitrate
- Ferrous Iron
- Sulfate
- Oxidation/Reduction Potential
- Total Organic Carbon
- pH
- Temperature
- Chloride

4.14 *INVESTIGATION DERIVED WASTE*

Investigation derived waste (IDW) will be characterized and managed in general accordance with the site-specific *IDW management Plan,* the EISOPQAM and state and federal regulations.

Waste containers will be labeled with pertinent information including their contents (when known), generation date, and the generator. The containers will be stored on-site in a designated area or areas. Disposal of the same will be scheduled in a timely manner after the contents of the containers are adequately characterized.

5.0 SAMPLE HANDLING AND MANAGEMENT

5.1 SAMPLE PRESERVATION

When possible, sample containers will be provided by the contract laboratory with preservatives as per the analytical method. If required as per the analytical method, samples will be preserved immediately upon collection in the field. Table 2 lists the preservatives required for the parameters to be analyzed.

5.2 SAMPLE NUMBERING SYSTEM

Each sample will be assigned a unique sample ID number that will be recorded on the sample label, in the field notes, and on chain-of-custody form. The sample numbering is described in more detail below.

Samples will be identified by a prefix (e.g., "SW" for "S"urface "W"ater) and a unique sample location number corresponding to a location on a map (e.g., SW-1). Depths will be added in parenthesis (e.g., "SW-1 (0-1) ", representing the "0-1 ft. below the water surface"). Other potential prefixes for sample media include:

- SW - Surface Water (water collected from ponded or flowing water at the ground surface)
- SB - Soil Boring (soil sample collected at or below the ground surface)
- MW - Monitor Well (water or soil collected at a permanent monitor well location)
- TMW - Temporary Monitor Well (water or soil collected from a temporary well boring)
- SS - Sediment Sample (sediment deposited by moving water or on the bottom surface of a water body)

Other unique alphanumeric codes may also be used, as necessary. For example, samples collected from a monitor well will utilize "GW" to signify "Ground Water" and "S" to signify "Soil". Therefore, a soil and ground water sample collected on the same date from monitor well MW-1 would be identified as "MW-1-S (9-10)" and "MW-1-GW".

QC samples will be clearly marked with unique alphanumeric codes. For example, "D" may be inserted in the sample ID to identify a "Duplicate" sample. An example ground water duplicate sample ID from MW-1 would be "MW-1-D (GW)". Other potential QC codes are listed below:

- D - Duplicate
- BD - Blind Duplicate (Note: BDs will not be dated, but accurate field notes will be taken so each blind duplicate can be associated with its corresponding investigative sample.)
- MS/MSD - Matrix Spike/ Matrix Spike Duplicate
- EQ - Equipment Blank
- FB - Field Blank
- TB - Trip Blank

The order in which the prefixes, suffixes, and/or alphanumeric codes will be used in a sample ID is as follows:

1. Prefix Identifier (e.g., "MW" for "Monitor Well") coupled with a unique number (e.g., "1") that correlates to a location on a map. (Note: for a composite sample, the prefix identifier would include "Comp", for example "SB-Comp-1").
2. QC Identifier (e.g., "EQ" for "Equipment Blank").
3. Media Identifier (e.g., "GW" for "Ground Water"), if necessary.
4. Depth Interval (e.g., "(0-1)" for "zero to one foot below surface"), if necessary.

Composite samples will be identified as stated above and noted in the field records. The sample ID will also include all sample IDs that were incorporated into the composite sample in the field records.

5.3 *SAMPLE CONTAINERS AND PACKAGING*

Sample container type, size, preparation, preservatives (as necessary), and holding times are provided in Table 2. Sample containers will remain closed prior to their use. After filling a container, it will be closed as soon as practicable and immediately placed on ice in an insulated cooler, using bubble wrap, as necessary, to protect glass containers.

Samples will be maintained at a nominal temperature of 4 °C and transported to the contract laboratory in a timely manner following sample collection to facilitate analysis within the specified method holding time. Samples will be transported in accordance with applicable state and federal regulations. Alternatively, samples will be hand-delivered to a courier service or the contract laboratory.

All samples will be adequately identified from the time of sample collection and packaging through storage and transportation to the contract laboratory. Sample labels will be affixed to the sample container and clearly labeled using a waterproof pen.

5.4 *SAMPLE CUSTODY AND TRANSPORT*

Samples are physical evidence collected from a site or the environment. An essential part of any sampling and analytical scheme is maintaining the integrity of the sample from its collection in the field to its analysis at the contract laboratory. This includes the ability to trace the possession and handling of samples from the time of collection through analysis and final disposition. A sample is considered to be in custody under the following conditions:

- It is in a person's physical possession;
- It is in view of the person after he/she has taken possession;
- It is secured by that person so that no one can tamper with the sample; or
- It is secured by that person in an area, which is restricted to authorized personnel.

Environmental samples will be handled under strict chain-of-custody procedures, beginning in the field. The designated field team leader will be the sample custodian and will be responsible for following the procedures outlined in this section. Recordkeeping of sample custody for field activities will include the use of chain-of-custody forms, sample labels, custody seals, and field logbooks. Field logbooks along with other field records will be used throughout the investigation to document the activities.

Laboratory-supplied containers will be used for samples of environmental media. However, if a situation arises where the field team uses sample containers not supplied by the laboratory, it will be noted on the chain-of-custody form.

Each sample label will include:

- Project number;
- Sample identification number;
- Sample collection date and time;

- Constituents to be analyzed or analytical method to be performed; and
- Initials of individual(s) collecting the sample.

The chain-of-custody form will include:

- Sample identification number and matrix;
- Project or facility name;
- Sampler's name(s);
- Sample date and time;
- Designation as a grab or composite sample;
- Requested analyses;
- Whether the sample was filtered or unfiltered;
- Preservatives added to the sample; and
- Other miscellaneous notes.

When multiple analytical methods are available for a particular analysis, the specific method number will be listed on the chain-of-custody form.

If required and appropriate for the project, the chain-of-custody form will indicate whether there are any additional analytes. When additional sample volume has been supplied for MS/MSD analysis, the same will be documented. A trip blank will be included in each sample cooler with samples designated for analysis of VOCs.

Samples will be packed in a shipping container (usually a cooler) in a manner that will reduce the potential for sample bottles to break. This might include the use of laboratory-supplied bubble wrap designed to fit the particular bottle or polystyrene chips. In addition, the sample containers will contain enough ice in Ziploc®-plastic bags to maintain a nominal temperature of 4° C during their transport to the laboratory.

The field technician or other field personnel will sign the chain-of-custody form relinquishing custody to the contract laboratory. The airbill number, if applicable and appropriate, will be recorded on the chain-of-custody form in the comments section. One copy of the completed chain-of-custody form along with a copy of the airbill will be kept in the project files.

The chain-of-custody will be sealed inside a Ziploc®-plastic bag to prevent potential for damage from condensation or broken sample bottles, and placed inside the shipping container for transportation to the laboratory.

Whenever possible, chain-of-custody seals will be signed and dated, and the serial numbers listed on the chain-of-custody form. Seal(s) will be used on each shipping container and placed in a location that would preclude opening the cooler without breaking the seal. The courier does not need to sign the chain-of-custody form if it is sealed within the shipping container using custody seals. Samples will typically be transported to the contract laboratory via overnight courier (e.g., Federal Express) or hand delivered.

6.0 DOCUMENTATION AND RECORDKEEPING

Records of information/data collected during the remedial action will be managed in a manner that facilitates subsequent analysis and assessment of the results. Records will require consistent labeling and documentation of field observations to support future data reduction and analysis, and to eliminate the need for speculation concerning the quality of observations or the influence of environmental factors on the data. Much of the data collected will be entered into a database for accurate retrieval and presentation.

ERM will retain appropriate documentation in the project files for a period of five years.

6.1 FIELD LOG BOOK DATA COLLECTION

During each sampling event, field notes will be recorded in a durable, project-specific, field log book. Field notes serve to document weather, prevailing conditions, daily activities, sampling procedures, etc. Field notes will typically include:

- Name and affiliation of the sampler(s);
- Purpose of the sampling activities;
- Date and time of the sampling activities;
- Sample type;
- Sample location description;
- Number of samples collected;
- Sample identification numbers (as described in Section 5.2);
- Test data or measurements (e.g., hydraulic test data);
- Volume of water generated during well sampling activities, purging, and/or development;
- Field observations (prevailing conditions and other relevant factors that might influence sample integrity);
- Field measurements; and
- Name and signature of the person(s) responsible for the sampling activities/observations.

In addition to the above information, any unusual conditions or problems encountered will be described to potentially aid in data interpretation at a later date.

Bound field logbooks will be used to document the sampling activities. Field forms will be used to record some of the information and are described in the following subsections.

6.1.1 *Field Boring Log*

This form has two main sections:

- The top section records pertinent data (e.g., Depth of Hole, Project No., Project Name, Boring No., etc.); and
- The bottom section graphically represents the boring.

An example of a Field Boring Log is provided as Attachment A.

6.1.2 *Monitor Well Installation Log*

This form has two main sections:

- The top section records pertinent data (e.g., Project No., Project Name, Well No., Drilling Method, etc.); and
- The bottom section records a materials inventory (e.g., Well Casing, Well Screen, Bentonite Seal, etc.) and graphically represents the well.

An example of a Monitor Well Installation Log is provided as Attachment B.

6.1.3 *Well Development Field Record*

This form has three main sections:

- The top section records pertinent data (e.g., Project Name, Project No., Well No., Developed By, etc.) about a particular well;
- The middle section records well development information (e.g., Date/Time, Volume of Ground Water Removed, Field Parameters, etc.); and
- The bottom section records development method(s) and other, miscellaneous notes.

An example of a Well Development Field Record is provided as Attachment C.

6.1.4 *Sample Collection Form*

This form has four main sections:

- Sample information (e.g., Sample No., Sample Location, Sample Date, etc.) and weather conditions (e.g., Temperature and Precipitation);
- Water level data (i.e., depth to water);
- Field measurements (e.g., pH, SC, etc.); and
- Sampling method (e.g., bailer, peristaltic pump, etc.) and samples collected (e.g., Analysis Required, Type and Size of Sample Container, etc.).

All samples collected will be recorded on the form, regardless of the sample matrix. Although it is recognized that some of the fields on the sample collection form only pertain to aqueous matrices or groundwater sample collection, other parts of the form contain useful information for all matrices.

An example of a Sample Collection Form is provided as Attachment D.

6.2 *ANALYTICAL DATA REPORTING REQUIREMENTS*

Laboratory analysis of environmental samples will be completed by contracted laboratories and will comply with the following analytical data reporting requirements. The following components will generally be required for each analytical data report:

- Sample identification number;
- Date sampled;
- Date analyzed;
- Analytical laboratory;
- Chemical Abstract Service (CAS) number, if applicable;
- Analyte name;
- Dilution factor, if applicable;
- Analytical methodology;
- Analytical result;
- Qualifier(s) applied to the result by the lab and/or data validators;
- Units of measurement;
- Matrix;
- Reporting (or detection) limit; and
- A Suffix or Other "Flag", if it is a Duplicate Analysis.

7.0 *MANAGEMENT OF CHANGE*

Significant proposed changes in sampling procedures, as outlined in this SAP, will be reviewed and approved by the ERM Project Manager, the designees of the responsible party(ies), and NCDENR prior to implementation. Minor procedural changes may be effected with the concurrence of the ERM Project Manager. Changes to the sampling procedures due to field conditions will be approved by the ERM Project Manager and documented in field logbooks.

If at any time significant changes or amendments to this SAP are deemed necessary, they will be incorporated into this SAP by use of an addendum or supplemental SAP that will be submitted to NCDENR for approval prior to implementation of the proposed changes/ amendments. Addendums or supplemental SAP-related documents will typically consist of a brief letter to TDEC explaining the changed conditions and the proposed course of action. Subsequent to NCDENR approval, the addendum or supplemental SAP-related document will be incorporated into this SAP and will supersede any conflicting requirements.

Figures

MAP SOURCE: HIGH POINT EAST (1982) 7.5 MINUTE NC TOPOGRAPHIC QUADRANGLE

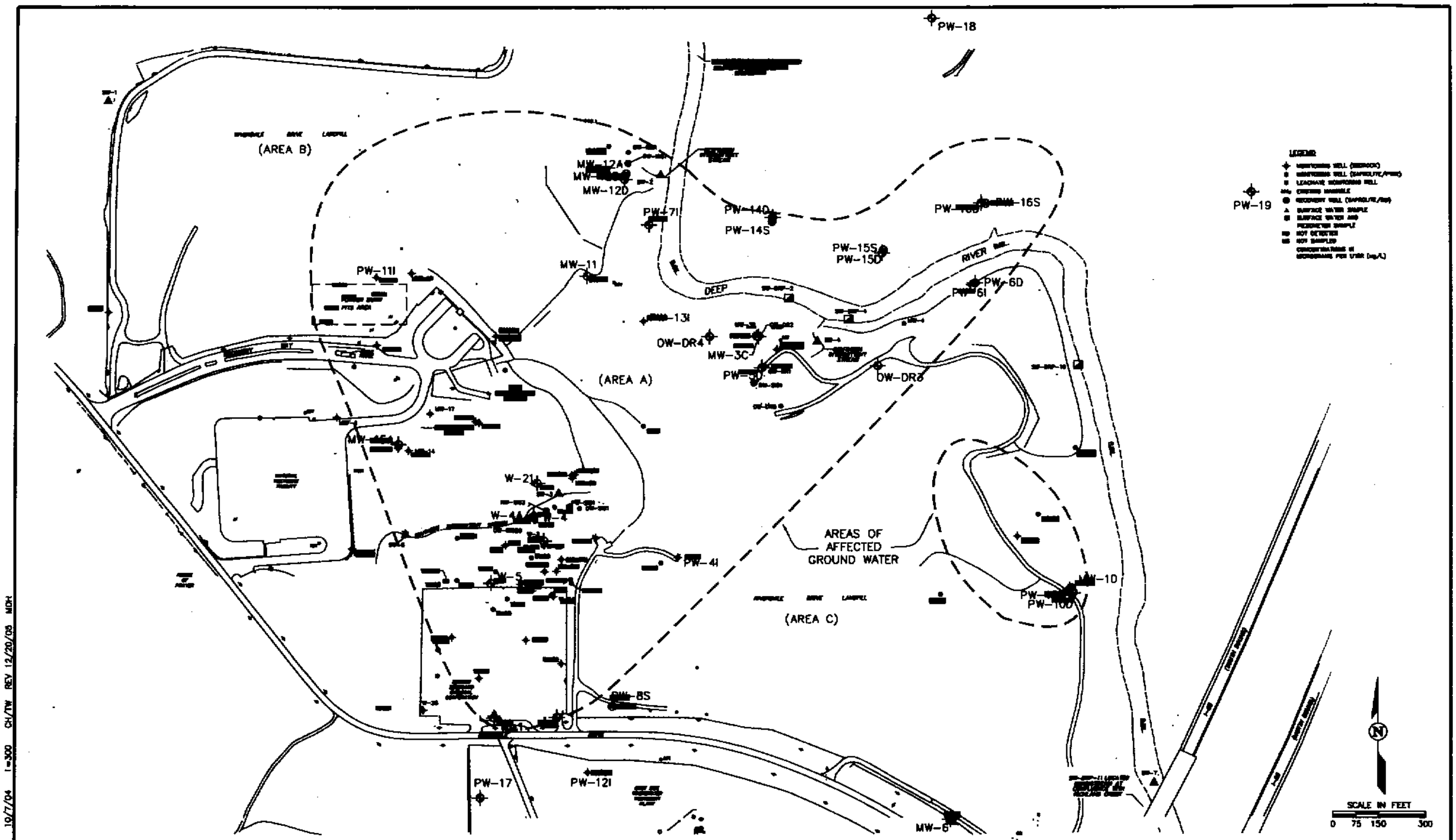
ERM

ERM NC, PC

SITE LOCATION MAP
FORMER SEABOARD CHEMICAL CORPORATION AND RIVERDALE DRIVE LANDFILL
JAMESTOWN, NORTH CAROLINA

FIGURE **1**

FIG 1 9-02.DWG 11/12/02 1=1 CH/TW



BASE MAP FROM BBL REMEDIAL INVESTIGATION REPORT, MARCH 1999.

NOTE: WELLS TO BE SAMPLED SHOWN IN ENLARGED TYPE

ERM

ERM NC, PC

SITE MAP AND GENERAL AREA OF AFFECTED GROUND WATER
FORMER SEABOARD CHEMICAL/
RIVERDALE DRIVE LANDFILL
JAMESTOWN, NORTH CAROLINA

FIGURE 2

FIG 2 9-04G.DWG 10/7/04 1=300 CH/TW REV 12/20/05 MDH

Tables

Equipment	Use
GENERAL EQUIPMENT	
Masking tape and/or pre-printed adhesive labels	Record keeping sample shipping
Containers for travel blanks, field blanks, sample replicates	Labelling containers
Waterproof notebook, pens, and field logs	Quality control check
Decontamination solutions: Organic-free water, 0.1 N HNO_3	Decontaminating solutions
Paper towels, aluminum foil, gloves, glass or stainless steel squirt bottles and/or sprayers	Decontamination
Large plastic garbage bags	Trash cans
Cooler/ice	Sample storage/preservation
Chain-of-custody forms	Recordkeeping
Clear tape, sample seals and chain-of-custody seals	Cooler shipping
Tool box	Miscellaneous repairs
Gasoline in approved storage can	Pump fuel
Camera and film	Activity photographs
Personal protective equipment	Worker health and safety
WATER SAMPLING EQUIPMENT	
Monitor well list/location map	Sampling plan reference
40-mL screw cap vials with Teflon septa	Sample containers for VOCs
Plastic and glass sample bottles	Metals, Anions, SVOCs Mn/Fe, TDS, BOD/COD sampling
Keys	Unlock monitor wells, gates
Calculator	Field calculation

Equipment	Use
WATER SAMPLING EQUIPMENT (continued)	
Electronic water-level indicator	Determine water levels & total depth
Submersible pump with tubing, cable, electrical cord	Well evacuation
Generator	Power source
55-gallon plastic trash container/plastic sheeting	Submersible pump storage
Peristaltic pump with Teflon tubing	2-inch well evacuation and sampling
Pyrex beaker	Surface water sampling
Stop watch	Record evacuation time
pH meter, conductivity meter, thermometer, turbidity meter dissolved oxygen meter, beaker, buffers	Field measurements
Ziploc bags or equivalent	VOC vial storage
5-gallon container	Measure flow rates
SOLID/SEMISOLID SAMPLING EQUIPMENT	
Soil boring location map	Sampling plan reference
Large polyethylene or polypropylene containers, with lids	Transfer vessels for collections of treatability study composite samples
Stainless steel hand augers and spoons, mixing bowls	Soil, sludge and sediments sampling
Ziploc plastic bags	Soil, waste and sediments sample containers
Plastic and glass sample bottles	Soil, waste and sediment sample containers

Equipment	Use
SOLID/SEMISOLID SAMPLING EQUIPMENT (continued)	
OVA/Tipmeter	VOC field screening
SURFACE-WATER ASSESSMENT	
Surface-water assessment map	Sampling plan reference
Boat	Collect samples from Randleman Lake
Anchor	Hold boat in place
Stakes and flagging	Identify transect across Deep River
pH meter, conductivity meter, dissolved oxygen meter and thermometer, buffers	Field measurements
Beakers	Field measurements
Measuring tapes and stick	Measure depth and width of Deep River
40-mL screw cap vials with Teflon septa	Sample containers for VOCs
Plastic and glass sample bottles	Sample containers for SVOCs, BOD and COD
Subsurface grab sampler (Subsurface Grab Sampler, Kemmerer-style sampler, Ben Meadows Company, Atlanta, Georgia, or equivalent)	Deep water sample in Deep River
Float	Measure flow velocity using float method
Stop watch	Measure time
Current meter (Marsh-Birney, Inc. Flo-Mate 2000)	Measure flow velocity using current meter method
Tag Line	Measure stream/river width

Equipment	Use
SURFACE –WATER ASSESSMENT (continued)	
Top-settling wading rod	Measure stream depth
Polypropylene tubing ((½" O.D.), wire mesh screen, and nylon Ties (¾" O.D.) and loose fitting steel bolt	Mini-piezometer construction
Drive rod	Mini-piezometer installation
Sledge hammer	Piezometer installation
Steel stakes	Anchor for mini-piezometers
Stainless steel well point and galvanized or stainless steel pipe (1¼" O.D.) and cap	Piezometers in Randleman Lake
Brightly colored float	Mark piezometer location in lake to ensure visibility by boaters.
Electric water-level meter	Measure the depth to water
Peristaltic pump	Purge temporary piezometer

Notes:
1 – Adapted from Table 2-1 of Geraghty & Miller, Inc., *Sampling and Analysis Plan,* November 16, 1995.

Table 2: Summary of Analytical Methods, Holding Times, Containers, and Preservation Requirements
Former Seaboard Chemical/Riverdale Drive Landfill Site - Jamestown, North Carolina

Water

Name	Analytical Method	Extraction Holding Time	Analysis Holding Time	Container Type	Container Volume	Sample Preservative	Comments
VOCs	SW846 8260B	NA	14 days	G, vials	40 ml	4°C, HCl (pH<2)	Includes 1,4-Dioxane
SVOCs	SW846 8270C	7 days	40 days	G, amber	1000 ml (2)	4°C	
Pesticides	SW846 8081A	7 days	40 days	G, amber	1000 ml (2)	4°C	
PCBs	SW846 8082	7 days	40 days	G, amber	1000 ml (2)	4°C	
TAL Metals	SW846 3005/6010B	NA	6 months	P, G	250 ml	HNO_3 (pH<2)	
Nitrate	SW846 353.2/9200	48 hours	48 hours	P, G	100 ml	4°C	
Sulfate	SW846 375.4/9036	28 days	-	P, G	100 ml	4°C	
Total Organic Carbon	SW846 415.1/9060	-	28 days	P, G	100 ml	4°C, H_2SO4 (pH<2)	
Chloride	SW846 325.2/9251/9252	-	28 days	P, G	100 ml	-	

Soil

Name	Analytical Method	Extraction Holding Time	Analysis Holding Time	Container Type	Container Volume	Sample Preservative	Comments
VOCs	SW846 8260B	NA	14 days	Encore kits	5 g	4°C, Either preserved or frozen by the laboratory within 48 hours	Includes 1,4-Dioxane
SVOCs	SW846 8270C	14 days	40 days	G	8 oz	4°C	
Pesticides	SW846 8081A	14 days	40 days	G	8 oz	4°C	
PCBs	SW846 8082	14 days	40 days	G	8 oz	4°C	
TAL/RCRA Metals	SW846 3050B/6010B	NA	6 Months	G	8 oz	4°C	

Notes:
P = plastic   ml = milliliters   HCl = hydrochloric acid
G = glass   g = grams HNO_3 = nitric acid
oz = ounces

Field Boring Log Example

Appendix A

ERM

FIELD BORING LOG

BORING NUMBER

SHEET ______ OF ______

PROJECT NAME	PROJECT NUMBER	LOCATION	ELEVATION AND DATUM
DRILLING COMPANY	DRILLER	START DATE/TIME	COMPLETION DATE/TIME
DRILLING EQUIPMENT	DRILLING METHOD	COMPLETION DEPTH	TOTAL NO. OF SAMPLES

SIZE AND TYPE OF BIT	HOLE DIAMETER	NO. OF SAMPLES	BULK	SS	DRIVE	PITCHER
DRILLING FLUID	DRILLING ANGLE	WATER LEVEL	FIRST		AFTER _____ HOURS	
SAMPLE HAMMER TYPE DRIVING WT. DROP		GEOLOGIST/DATE				CHECKED BY/DATE

LITHOLOGY	DEPTH (feet)	SAMPLES	RECOVERY	BLOW COUNT	DESCRIPTION	USCS SYMBOL	ESTIMATED PERCENT OF			FID/PID READINGS	COMMENTS/ LAB SAMPLE IDENTIFICATIONS
							GR	SA	FI		

ERM

FIELD BORING LOG (CONTINUED)

BORING NUMBER

SHEET 2 OF

PROJECT NAME	PROJECT NUMBER	LOCATION	ELEVATION AND DATUM

LITHOLOGY	DEPTH (feet)	SAMPLES	RECOVERY	BLOW COUNT	DESCRIPTION	USCS SYMBOL	ESTIMATED PERCENT OF			FID/PID READINGS	COMMENTS/ LAB SAMPLE IDENTIFICATIONS
							GR	SA	FI		

Monitor Well Installation Log Example
Appendix B

LITHOLOGIC LOG & WELL COMPLETION RECORD

CLIENT:	**BORING I.D.:**
PROJECT NAME.:	**DATE STARTED:**
PROJECT NO.:	**DATE COMPLETED**
PROJECT LOCATION:	**"DRILLER/Cert. # / State :**
	DRILL METHOD:
	BORING DIAMETER:
SAMPLING METHOD/INTERVAL:	**TOTAL DEPTH (ft bls):**
WATER LEVEL:	**REMARKS:**

DESCRIPTIVE LOG

SAMPLE INTERVAL	SAMPLE REC. (IN.)	BLOWS PER 6"	PID/FID (ppm or %)	ELEVATION (ft msl)	GRAPHIC COLUMN WELL CONSTRUCTION	DEPTH (FT)	LITHOLOGIC DESCRIPTION OF MATERIAL	MOISTURE (RELATIVE)
						+1.5		
						+1.0		
						+ 0.5	*Land Surface*	
						0.5		
						1.0		
						1.5		
						2.0		
						2.5		
						3.0		
						3.5		
						4.0		
						4.5		
						5.0		
						5.5		
						6.0		
						6.5		
						7.0		
						7.5		
						8.0		
						8.5		
						9.0		
						9.5		
						10.0		
						10.5		
						11.0		
						11.5		
						12.0		
						12.5		
						13.0		
						15.0		

DRILLING METHODS
AIR - AIR ROTARY
CFA - CONTINUOUS FLIGHT AUGER
DC - DRIVEN CASING
HA - HAND AUGER
HSA - HOLLOW STEM AUGER
MD - MUD DRILLING
RC - ROCK CORING
WR - WATER ROTARY
DPT - DIRECT PUSH TECHNOLOGY
* - Sample collected for analysis

SAMPLING METHODS
SS - SPLIT SPOON
ST - SHELBY TUBE
NR- NOT RECORDED

GRAPHIC COLUMN
GROUT
BENTONITE
SAND
SCREEN

ERM NC, PC
8000 Corporate Center Drive
Suite 200
Charlotte, NC 28226
704-541-8345

Well Development Field Record Example

Appendix C

ERM

MONITORING WELL DEVELOPMENT RECORD

WELL NUMBER ______________
PROJECT NUMBER ______________
PROJECT NAME ______________
DATE INSTALLED ______________
DATE DEVELOPED ______________

WELL DATA

Constructed Depth of Well (ft.) ______________
Radius of Well, r_c (ft.) r_c = ______________
Radius of Borehole/Sand Pack, r_a (ft.) r_a = ______________
Vertical Length of Standing Water in Well Casing, h_s (ft.) h_s = ______________
Effective Porosity of Sand Pack Material, n_e n_e = ______________
Height of Well Casing Above/Below Ground Surface (ft.) ______________

MEASUREMENTS AND CALCULATIONS

Depth to Static Water Before Development (ft.) ______________
Depth to Top of Sediment Before Development (ft.) ______________
Vertical Length of Standing Water in Well Casing, h_c (ft.) h_c = ______________
Volume of Water in Well and Sand Pack Prior to Development, V (gallons) where: v = ______________

$$V = \pi \, 7.48 \text{ gal/ft.}^3 \left[(r_c{}^2 h_c) + n_e h_s (r_a{}^2 - r_c{}^2) \right]$$

Nominal Quantity of Water to Remove for Development (gallons) (This is = 5V unless otherwise justified) 5v = ______________

DEVELOPMENT OBSERVATIONS

Physical Character of Water ______________

Type and Size of Well Development and Measuring Equipment ______________

Weather Observations ______________

Parameter	Gallons Removed from Well					
	0					
Time						
Spec. Conductance (μmhos/cm)						
Temperature (°C)						
PH (Standard Units)						
Turbidity (NTU)						

Total Quantity of Water Removed (gallons) ______________
Depth of Static Water After Development (ft.) ______________
Depth to Top of Sediment After Development (ft.) ______________

Sample Collection Form Example

Appendix D

FIELD SAMPLE COLLECTION REPORT	ERM	8000 Corporate Center Drive, Suite 200 Charlotte, NC 28226 (704) 541-8345	JOB NUMBER ______ JOB NAME ______ SAMPLING POINT (LOCATION) ______ DATE ______ TIME ______

SAMPLING INFORMATION

SAMPLE I.D. NUMBER: ______ HAZARDOUS?: ____ YES ____ NO ____ UNKNOWN

SOIL SAMPLING DATA:

SAMPLING DATE: ______

TIME: ______

SAMPLER TYPE & MATERIAL Stainless Steel Hand Auger : Geoprobe (polyethylene sleeve) (circle)

SAMPLING DEPTH ______

SAMPLE DESCRIPTION ______

WELL SAMPLING DATA:

SAMPLING DATE: ______

TIME: ______

PURGE METHOD & MATERIALS Peristaltic pump : hand bailer / polyethylene : teflon / tubing : bailer (circle)

VOLUME OF WATER IN WELL & SAND PACK (gallons) ______

VOLUME OF WATER PURGED (gallons) ______

PURGE DATE ______ START TIME ______ END TIME ______

SAMPLER TYPE & MATERIAL Peristaltic pump : hand bailer / polyethylene : teflon / tubing : bailer (circle)

SAMPLE DESCRIPTION ______

TOTAL WELL DEPTH ______ ft. DEPTH TO GROUND WATER ______ ft.

CONTAINER					
TYPE	VOLUME	PRESERVATIVE/PREPARATION	NUMBER	FILTERING	ANALYSIS

FIELD MEASUREMENTS

PARAMETER	EQUIPMENT ID	1st READING	2nd READING	3rd READING	4th READING
pH (STD UNITS)					
TEMP (C)					
SPEC. COND (um/sm)					
TIME					
DATE					

GENERAL INFORMATION

WEATHER ______ AIR TEMP. ______

SAMPLES COLLECTED BY ______

SPECIAL HANDLING SAMPLES PACKED IN COOLER ON ICE

MODE OF SHIPMENT ____ CAR/TRUCK ____ PLANE ____ COMMER VEH. ______ OTHER

COMMENTS (CALIBRATIONS, FIELD MODIFICATIONS, INSTRUMENT PROBLEMS) ______

N/A: Not Applicable